

**Manipulation of Gold Nanoparticles with Triblock Copolymer Micellar Template**

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Beamlines: X27C and X3A2

**Introduction:** Gold nanoparticles have many promising properties and can be used as an effective catalyst [1,2], such as in the oxidation of CO [3], NO, H<sub>2</sub> and ethylene glycol [4]. In this work triblock copolymers, such as E<sub>45</sub>B<sub>14</sub>E<sub>45</sub>(B20), (CH<sub>2</sub>CH<sub>2</sub>O)<sub>45</sub>-(CH<sub>2</sub>CH(CH<sub>3</sub>CH<sub>2</sub>)O)<sub>14</sub>-(CH<sub>2</sub>CH<sub>2</sub>O)<sub>45</sub>, that formed micelles in aqueous solution, were used as a template to synthesize gold nanoparticles.

**Methods and Materials:** Heptanethiol (or pentanethiol), being insoluble in H<sub>2</sub>O but soluble in ether, was dissolved in 5% or 10% B20 aqueous solution. Benzaldehyde was added to the solution with stirring in order to get a homogenous solution. 1% HAuCl<sub>4</sub> aqueous solution was then slowly (20-40 mg/hour) added to the above solution. The mixture solution changed from brown to green and then to a clear purple suspension. The precipitate was obtained by using a high-speed centrifuge. The samples were characterized by using a combination of small angle X-ray scattering (SAXS), dynamic light scattering (DLS) and transmission electron microscopy (TEM).

**Results:** It was found that the solubility of thiol in B20 aqueous solution increases with increasing B20 concentration; the micelle weight increased after addition of thiol. These results suggested that the thiol was dissolved in the micelle core formed by poly(1-butene oxide), a polyether. The DLS of the solution mixture revealed that the aggregate radius increased from 6 nm for micelle to 10-20 nm for the green colored sample and to 30-40 nm for the purple colored sample.

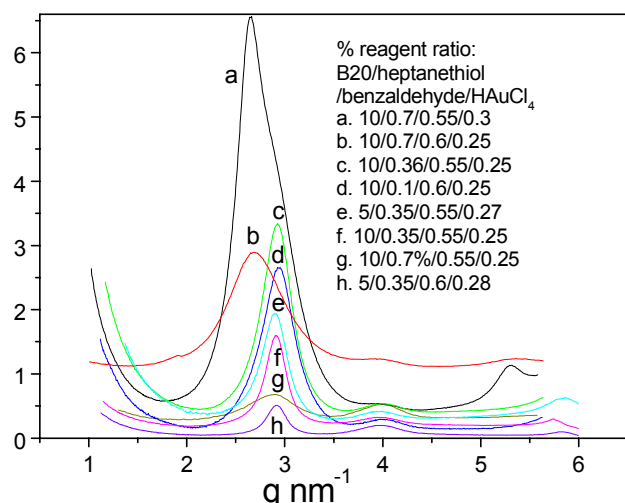
Figure 1 shows the SAXS results. The diameters of gold nanoparticles are 2.1-2.4 nm, close to the micellar core diameter and not related to the reagent ratio. Figure 2 shows the presence of aggregates in the TEM images. The black dots in the aggregate are gold nanoparticles formed in the micelle core, which are covered by the copolymer shell; the diameters of gold nanoparticles are 2.2-2.7 nm. Treated by a large amount of ethanol, the gold nanoparticles precipitated and collapsed together after the copolymer was removed by ethanol.

**Conclusions:** Gold nanoparticles were synthesized by using a triblock copolymer as a micellar template and the micelle dimension controlled the particle size.

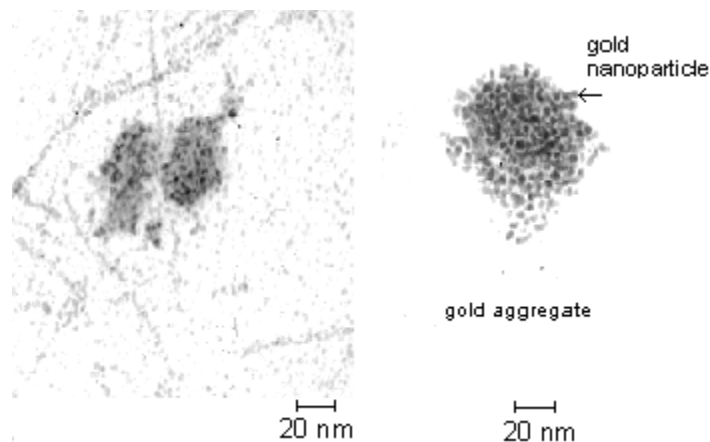
**Acknowledgment:** BC gratefully acknowledges support of this work by the US Department of Energy (DEFG0286ER45237.016) and the National Science Foundation (Polymers Program, DMR9984102)

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**Figure 1.** SAXS profile of the gold nanoparticles formed from different aqueous solution with different agent ratio



**Figure 2.** Two TEM images of gold nanoparticles and aggregates. The nano-dots as denoted by the black dots are the gold nanoparticle in the copolymer core